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ABSTRACT

Field studies are a primary means of obtaining scientific knowledge about earth science concepts. This paper discusses why a teacher might choose a field trip as an educational strategy important to the teaching and learning of earth science. Reasons to choose field trips as a teaching strategy, factors that influence learning on a field trip, and the components of an effective earth science field trip are presented. A list of earth science Internet sites for virtual field trips is provided. (Contains 26 references.) (YDS)

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VIRTUAL FIELD TRIPS IN THE EARTH SCIENCE CLASSROOM

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The Field Trip in the Earth Science Classroom

This paper is from the Preconference Workshop entitled "Preparation and Classroom Applications of Virtual Field Trips for Use in Elementary, Middle School, and Secondary Education."

Earth Science is "the field"

Everyone needs to know about the Earth because they live on it, walk on it, and are surrounded by every aspect of it. Earth Science teaching is conducted primarily in three different learning environments: in the classroom; in the laboratory; and in the outdoors (Orion and Hofstein, 1994). Outdoor field trips offer excitement, adventure, and visual, auditory, kinesthetic, olfactory and gustatory experiences for learning about our world and how it works. They are an effective tool to enhance academic learning and are the best technique with which to study real world events and processes (Appendix A).

To geologists, meteorologists, oceanographers, soil scientists, astronomers (and all other Earth scientists), the "field" is where are of the action is! Field studies consist of the methods used to examine and interpret structures, materials, and processes in real time and in the real world. Field studies are the primary means of obtaining scientific knowledge about the great ideas (concepts) of Earth Science. (Compton, 1962).

Why take a field trip?

The literature provides several reasons why a teacher might choose a field trip as a teaching strategy. These include:

1. Promote increased learning (Benz, 1962; Sorrentino and Bell, 1970; Mason, 1980; Watkins and Guccione, 1992).

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2. Provide input in all 5 sensory modes (Stonehouse, 1984; Lovedahl and Tesolowski, 1986; Woerner and Stonehouse, 1988)

3. Need for concrete experiences (Novak, 1976; Orion, 1993)

4. Act as subsumers for further learning in the classroom (Novak, 1976)

5. Concentrate on processing, or the generation of meaning (Wittrock, 1974; MacKenzie and White, 1982)

6. Increase motivation and provide a new or different environment for the students which may change their attitude toward the class or the subject (Kern and Carpenter, 1984; McKenzie, Utgard, and Lisowski, 1986; McCombs, 1990).

7. Provide a new environment for the teacher to observe students and their learning strategies.

Prather (1989), in his review of the value of field trips in science instruction, concluded that field trips are effective for both factual and conceptual learning and for achieving affective objectives. In addition, he states, "compared to other traditional teaching techniques, field trips may provide an especially rich stimulus setting for content learning and may excel in generating a natural inclination to learning." Prather reminds us that field trips are not inherently effective instructional tools, and that learning is a result of careful planning and preparation to ensure that the field trip learning is related to the intended instructional objectives. How effective a field trip is depends on how well they are planned and structured so that they do more than provide a novel environment.

Factors which influence learning on a field trip

Orion and Hofstein (1994) studied factors which influence learning during scientific field trips and delineated three categories of factors which could influence learning by students:

1. tea*ching factors*, such as the place of the field trip in the curriculum structure, didactic methods, learning aids, and quality of teachers;

2. *field trip factors*, such as the learning conditions at each learning station, duration and attractiveness of the trail, weather conditions during the field trip;

3. *student factors*, such as previous knowledge to trip topics, previous acquaintance with trip area, previous experience in field trips, previous attitudes toward subject matter, previous attitudes to field trip, and class characteristics (grade, size, area of interest, major)

What are the components of an effective Earth Science Field Trip?

A review of the literature provides the following components which should be included if the Earth Science field trip is to be effective. These are:

1. Must be linked to and integrated with the curriculum (Orion and Hofstein, 1994; Millan, 1995)
2. Careful selection of concepts to be learned (Novak, 1976; Orion, 1993)
3. Focus attention on what is to be learned — specify objectives and focus students on them (Koran and Baker, 1979; Rudmann, 1994; Miller, 1995)
4. Advance organizer and relevant knowledge prior to trip to provide scaffolding (Koran and Baker, 1979; Orion and Hofstein, 1994; Rudmann, 1994)
5. Plan activities and relevant information prior to field trip to reduce "novelty space" [cognitive preparation-geographical preparation-psychological preparation] (Koran and Baker, 1979; Orion, 1993)
6. Focus on concrete activities which cannot be conducted effectively in the classroom; process oriented approach (Orion, 1993)
7. Pace of learning in continuous and flexible (Koran and Baker, 1979)
8. Students move around and participate actively Koran and Baker, 1979) using all five sensory modalities (MacKenzie and White, 1982; Lovedahl and Tesolowski, 1986; Woerner and Stonehouse, 1988)
9. Students generate information, rather than receive it, and construct their own records of the scene (MacKenzie and White, 1982)
10. Assessment or evaluation is congruent with teaching/learning strategies used on the trip

The Virtual Field Trip

What is a Virtual Field Trip?

A Virtual Field Trip is a journey taken without actually making a trip to the site. It should be undertaken as an integral part of the curriculum and address concepts and processes which have been carefully selected by the teacher. In reality, it is any trip taken via an alternative means, and could include slides, a set of rocks appropriately placed around the classroom, a stream table, a movie or video, a CD-ROM, or the use of the Internet and Web Sites about a particular site.

Although all of these would qualify as "virtual" field trips, within the scope of this workshop, a "Virtual Field Trip" is taken with the computer as the vehicle which "moves" students in virtual space and time to a particular real world site.

Why take a Virtual Field Trip?

Virtual Field Trips are a method of providing field experiences that take students to places that, until now, the teacher could only dream about — and these virtual field trips help teach things students might not otherwise learn. Although each teacher does not have a spectacular example on the school grounds to illustrate an Earth Science concept right at the moment it is needed, a trip to such a site is right at the teacher's fingertips. In addition, there are some place you just can't go in the real world!

In addition, various constraints (such a lack of knowledge about the local environment, cost of transportation, time needed for organization, worries about lawsuits etc.) cause teachers to select classroom and laboratory experiences rather than taking students into outdoor environments. During a real world field trip, examples described in the textbook may not be obvious, the site may require great physical exertion or be unsafe, or the weather may be lousy.

The World Wide Web is touted to be able to transform teaching and learning. With the Web's ceaselessly increasing capacity for multimedia, multimodal communication, information presentation, and easy access to an exponentially increasing body of knowledge, the ways in which students learn and interact in classrooms is changing. (Appendix B provides a list of Web

sites which have Virtual Field Trips.) Just as is the case with real world field trips however, Virtual Field Trips are not inherently effective instructional tools, and learning is a result of careful planning and preparation (Prather, 1989; Pedretti, 1998; Zhao, 1998). As with its real world counterpart, students need time for exploring, making observations, taking wrong turns, testing ides, doing things over, collaboration, collecting things, and constructing models for testing ideas. They also need time for learning prerequisite concepts they may need to deal with the questions at hand (Myers and Botti, 1997).

New interactive technologies create new roles for teachers, present opportunities for and barriers to effective instruction, affect student and teacher satisfaction, and demand increased teacher time to learn to use the emerging virtual environments. To be effective, a virtual field trip must be designed using models and theories of human learning (including active learning) and effective instructional design.

What are the components of an effective Virtual Earth Science Field Trip?

Good Virtual Field trips have many features (Table 1) of effective real-world field trips. (The Virtual Geography Department, 1997; Gray, 1997; TLC Systems, 1998).

Table 1
Components of Effective Virtual Field Trips

The Virtual Field Trip should have:

- a specific focus or objective(s) which is clearly stated
- an integral part in the classroom learning
- a pre-trip orientation with concrete activities
- a navigator to guide students easily around the field trip site
- a post-field trip follow-up with activities and debriefing

The students should be able to:

- move around at their own speed and select what is meaningful to them to see and experience
- interact with the field trip environment and use multiple sensory modalities

- have access to content experts who understand the events, processes, and concepts illustrated at the site
- make observations, collect and analyze data, and construct their own explanations
- compare their observations and explanations to those made by other students and field "experts"

The online features should:

- be rich in context and aesthetically pleasing
- a navigator to guide students easily around the field trip site
- have online resources which provide easy access to the content
- relate the focus or objectives to the curriculum content of the site
- use the unique features of the Web
- accommodate multiple modalities and learning styles
- facilitate independent investigation and cooperative group work
- contain suggested off-line student activities
- contain appropriate links to related sites

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APPENDIX A

Learning Success

Learning tends to be a rather haphazard activity. The most successful teachers have learned from experience and they do intuitively whatever is necessary to promote learning. What is known about learning strategies is that learners receive information through one of their five senses and store is using the same sensory modality. When people represent what they know in conscious memory (remember). they again use the same sensory modality in which they received the information (Dilts, Grinder, Bandler, Cameron-Bandler, and DeLozier, 1980 and Woerner and Stonehouse, 1988).

Earth Science education is often mistakenly considered to be less important, less rigorous, or a non-college entrance course. Earth Science is, perhaps, less precise than Biology, Chemistry, and Physics, but it is much more complex in terms of systems' interactions. Where else can one deal with Astronomical Units and pico seconds or with the size of the universe and subatomic particles all in the same lesson? What other science involves four dimensions — three spatial and one temporal. What other science ties its abstract thinking so closely to objects we have all experienced as intimately as rocks, water, and air? Earth Science is not simple, but it can provide a motivation for significant learning (Stonehouse, 1984).

All Earth Science teachers are aware of their students' almost universal satisfaction with "hands-on" activities which are an essential part of Earth Science teaching. The reason it is satisfying is that is produces a break in the (perceived) monotony of sitting still and reading, and it also engages two (Visual and Kinesthetic) modalities (representational systems) simultaneously which produces a stronger motivation to learn. Field activities, even though they may only involve sampling the soil in the school yard, have a similar or stronger effect because they tap into remembered pleasant visual, kinesthetic, and other images of "playing in the dirt" or just being outdoors (Stonehouse, 1984).

We have had uncountable informal experiences with the Earth which are there to be tapped as we engage in formal study of the Earth in the field. We can connect our new experiences to the informal ones, and we have more channels of input to help with remembering later on. A primary positive outcome of field trips is that they permit learner to experience sensory impressions that cannot be repeated in the classroom (Lovedahl and Tesolowski, 1986). Field study involves learning and remembering in more than one modality (often all five) which provides for more successful and more pleasant learning.

APPENDIX B

Earth Science Internet Sites

Virtual Field Trips

Virtual Geography Department
http://www.uwsp.edu/acaddept/geog/projects/index.htm

Deep Lock Quarry Physical Geography Virtual Field Trip
http://www.uakron.edu/geography/lrb/trips/dquarry/index.html

CESME Virtual Field Trips
http://cesme.utm.edu/projects/projects.html

Indian Peaks, Colorado, Front Range Virtual Field Trip
http://www.uwsp.edu/acaddept/geog/projects/virtdept/ipvft/start.html

Virtual Tour of the Mendenhall Glacier
http://www.snowcrest.net/geography/field/mendenhall/index/htm;

Virtual Tour of Mt. Hamilton and Lick Observatory
http://www.ucolick.org/pubinfo/tour.html
http://www.irving.org/cgi-bin/xplore.cgi?lick+hwyquim+A

The Virtual Mt. Shasta Climb
http://www.geocities.com/Yosemite/2483/shasmap1.htm

Shasta Virtual Field Trip
http://www.snowcrest.net/freemanl/shasta/index.html

Virtual Hawaii
http://www.satlab.hawaii.edu/space/hawaii/index.html

A Virtual Fieldtrip of the Geology of Kansas City
http://www.umkc.edu/sites/env-sci/virgeol/vftstart/vftstart.htm

Grand Canyon Explorer
http://www.kaibab.org/geology/gc_geol.htm

Virtual Field Trip of the Tomorrow River
http://www.uwsp.edu/acaddept/geog/courses/geog391/toriv/g391main.htm

Monterrey Bay Virtual Canyon Site
http://www.virtual-canyon.org/overview.html

The Virtual Cave
http://www.goodearth.com/virtcave.html

Houghton Mifflin Geology Virtual Field Trip Site
http://www.geologylink.com/fieldtrips/

The Virtual Field Trip Site
http://www.field-guides.com/

A Virtual Field Trip to the Birch Aquarium
http://www.rsf.k12.ca.us/Subjects/Birch/Birch.Aquarium.Fieldtrip.html

BigBend Virtual Field Trip
http://geoweb.tamu.edu/faculty/herbert/bigbend/intro/index.html

The NPS Mammoth Cave
http://www.nps.gov/maca/macahome.htm

Electronic Field Trip to Mammoth Cave
http://www.ket.org/Trips/Cave/Index.html

Geophysics Field Trips
http://gretchen.geo.rpi.edu/field_trips.html

Flynn Bogs
http://csdl.tamu.edu/FLORA/flynnbog/FB1.HTML

Geology of Georgia
http://www2.gasou.edu/geol/1.2TOC.html

Window on Arizona
http://www.geo.arizona.edu/Geo256/azgeology/

Haughton-Mars Expedition 1998
http://www.arctic-mars.org/

Telecom Amazon Adventure Home Page
http://vif27.icair.iac.org.nz/

Welcome Aboard the Earth Quest 2000 Homepage!
http://www.eq2000.com/

GOALS: Global Online Adventure Learning Site
http://www.goals.com/

Arctic Challenge
http://www.adventureonline.com/ige/index.html

The JASON Project
http://www.jasonproject.org/front.html

San Andreas Fault sites

Southern California Earthquake Center
http://www.scec.org/

Southern California Earthquake Center Data Center
http://www.scecdc.scec.org/

U.S,G,S, Pasadena Office
http://www-socal.wr.usgs.gov/

Seismological Laboratory at Cal Tech
http://www.gps.caltech.edu/seismo/seismo.page.html

U.S.G.S.Northern Office
http://quake.wr.usgs.gov/

University of California Berkeley Seismological Laboratory
http://www.seismo.berkeley.edu/seismo/seimso.baseis.html

The San Andreas Fault at the San Francisco Bay
http://sepwww.stanford.edu/oldsep/joe/fault_images/BayAreaSanAndreasFault.html

U.S.G.S. Publications on the San Andreas
http://pubs.usgs.gov/publications/text/San_Andreas.html

Hayward fault tour
http://www.mcs.csuhayward.edu/~shirschf/tour-1.html

The Hayward Fault at UC Berkeley
http://www.seismo.berkeley.edu/seismo/hayward/ucb_campus.html

Hollister Active and Passive Seismic Investigation
http://gretchen.geo.rpi.edu/roecker/hollister/hollister.html

San Fran Museum EQ links

http://www.sfmuseum.org/1906/89.html

Web Design sites

Web Page for Designers (in England)
http://www.wpdfd.com/wpdhome.htm

Web design by Lynda Weinman
http://www.Lynda.com/

HiveFive Info
http://www.HighFive.com/core/cover_left.html

tlc.webdesign
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Yale Web Design
http://info.med.yale.edu/caim/manual/contents.html